OCR
Oxford Cambridge and RSA

Friday 17 May 2019 – Morning

AS Level Physics A

H156/02 Depth in physics

Time allowed: 1 hour 30 minutes

You must have:
- the Data, Formulae and Relationships Booklet (sent with general stationery)

You may use:
- a scientific or graphical calculator
- a ruler (cm/mm)

H156/02

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

INSTRUCTIONS
- Use black ink. HB pencil may be used for graphs and diagrams.
- Answer **all** the questions.
- Where appropriate, your answers should be supported with working. Marks may be given for a correct method even if the answer is incorrect.
- Write your answer to each question in the space provided. If additional space is required, use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.

INFORMATION
- The total mark for this paper is **70**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended responses will be assessed in questions marked with an asterisk (*****).
- This document consists of **20** pages.

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Answer **all** the questions.

1 A student investigates the motion of a tennis ball of mass 57 g which falls vertically from rest, then bounces once on a soft horizontal surface.
Fig. 1 shows the variation with time t of the velocity v of the tennis ball falling from rest until it hits the soft surface.

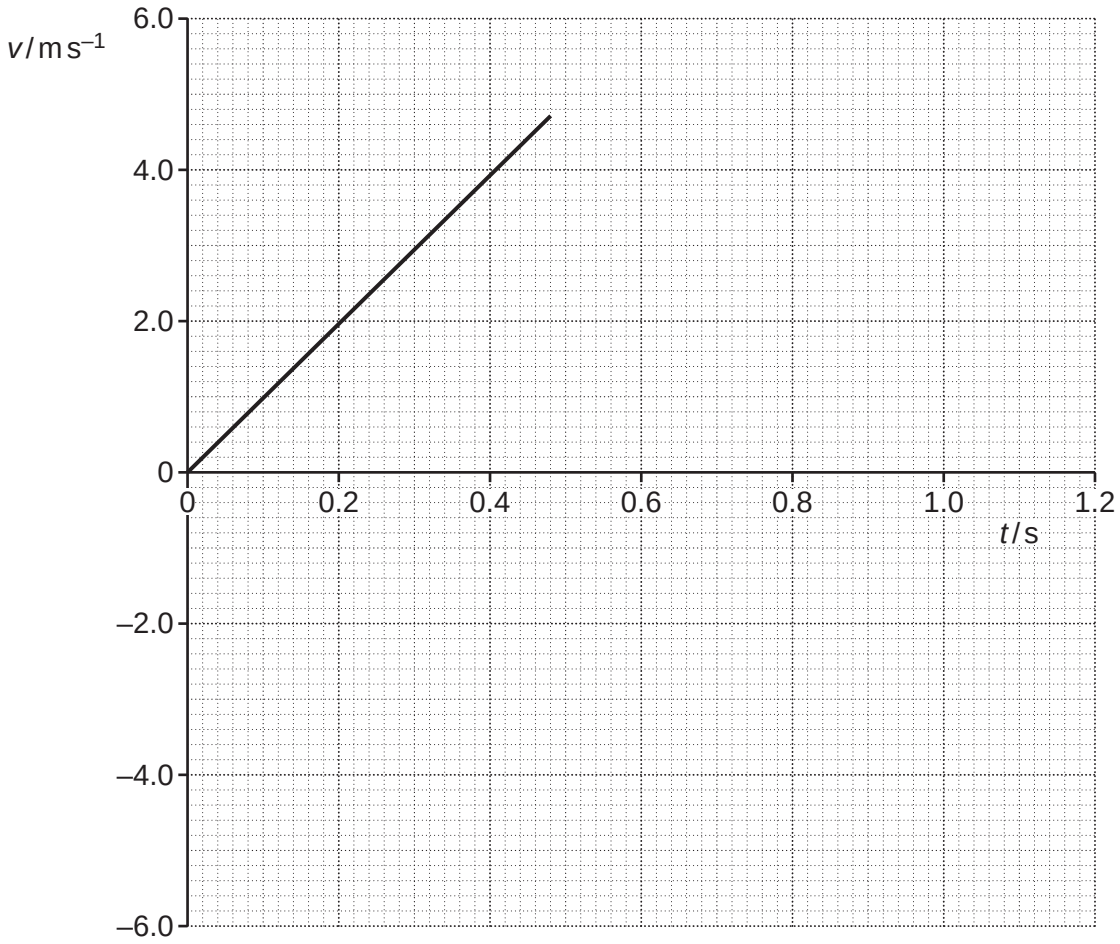

Fig. 1

Air resistance has a negligible effect on the motion of the tennis ball.

(a) Use Fig. 1 to show that

(i) the acceleration of the falling ball is about 10 m s^{-2}

[1]

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(ii) the kinetic energy of the ball just before impact with the surface is 0.63 J.

[2]

(b) The ball leaves the surface with 80% of the kinetic energy just before impact.

(i) Calculate the magnitude of the velocity v of the ball as it leaves the surface.

v = ... $m\,s^{-1}$ **[3]**

(ii) Complete Fig. 1 to show the variation of the velocity of the ball after it leaves the surface until it is at rest again.

[2]

(iii) Determine the maximum height h reached by the ball after it bounces.

h = ... m **[2]**

(c) The student repeats the experiment with a different ball that is affected by air resistance.

Explain how the graph in Fig. 1 now appears from the time the ball is released to the time it hits the surface.

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..... **[2]**

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2 **(a)*** A student is investigating the stretching of materials.
The student applies varying loads to material **J** and determines the stress and the strain until the material breaks.
The experiment is then repeated for a second material **K**.
Fig. 2.1 shows how the stress for each material varies with strain.

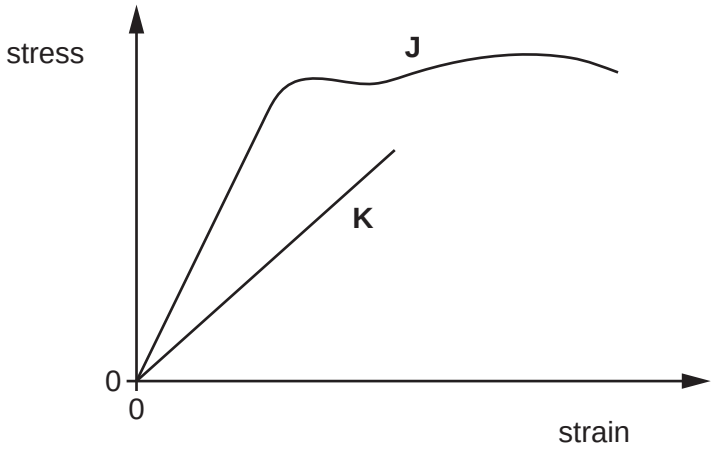

Fig. 2.1

Compare materials **J** and **K** using Fig. 2.1 and the six terms listed below.

brittle **ductile** **elastic** **plastic**

ultimate tensile strength **Young modulus**

Include in your answer an explanation of each term. **[6]**

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(b) A student is designing a three-legged wooden stool as shown in Fig. 2.2.

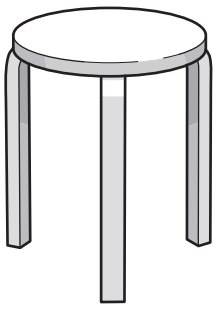

Fig. 2.2

The stool must be able to support the weight of an adult.
The maximum compressive stress of the wood is 2.3 MPa.

Estimate the minimum cross-sectional area *A* of **one** leg.

A = ... m^2 **[3]**

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3 **(a)** A student measures the diameter of a ball in different directions.
The student's results are:

2.43 cm 2.54 cm 2.59 cm

(i) State the name of a suitable measuring instrument to measure the diameter of the ball.

..... **[1]**

(ii) Calculate the mean diameter d of the ball.
Include the absolute uncertainty in d.

d = ... ± ..... cm **[2]**

(iii) Show that the volume of the ball is about $8.4 \times 10^{-6}\,m^3$.

[1]

(iv) The mass of the ball is 23 ± 1 g.
Determine the density ρ of the ball.
Give your answer to an appropriate number of significant figures.

ρ = ... kg m^{-3} **[2]**

(v) Determine the percentage uncertainty in ρ.

percentage uncertainty = ... % **[2]**

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(b) The 23 g mass ball from **(a)** is used in an experiment with a spring.

The student measures the unstretched length L_0 of a spring as shown in Fig. 3.1.

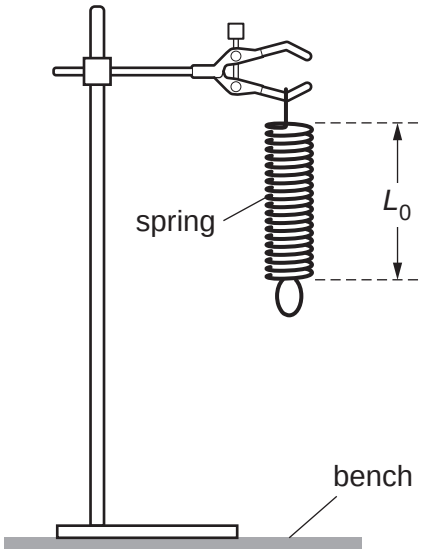

Fig. 3.1

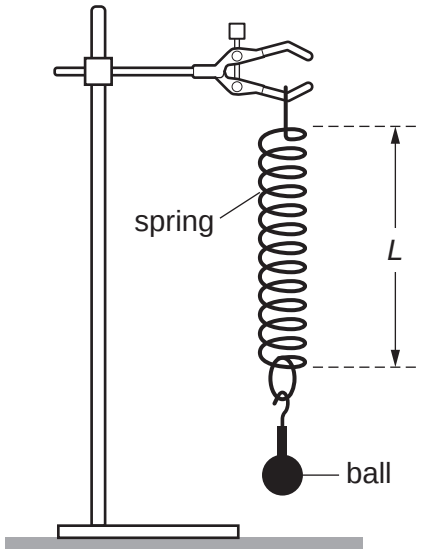

Fig. 3.2

The student then attaches the ball to the spring and measures the length L of the spring as shown in Fig. 3.2.

The student's results are:

$L_0 = 0.078\,\text{m}$ and $L = 0.096\,\text{m}$

Calculate the force constant k of the spring.

$k =$ ..... N m^{-1} **[3]**

Question 3 continues on page 8

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(c) The 23 g mass ball from **(a)** and the spring from **(b)** are now used in an experiment to investigate upthrust.

The ball attached to the spring is lowered into a beaker containing a liquid so that it is totally submerged. The student measures the new length L_N of the spring, as shown in Fig. 3.3.

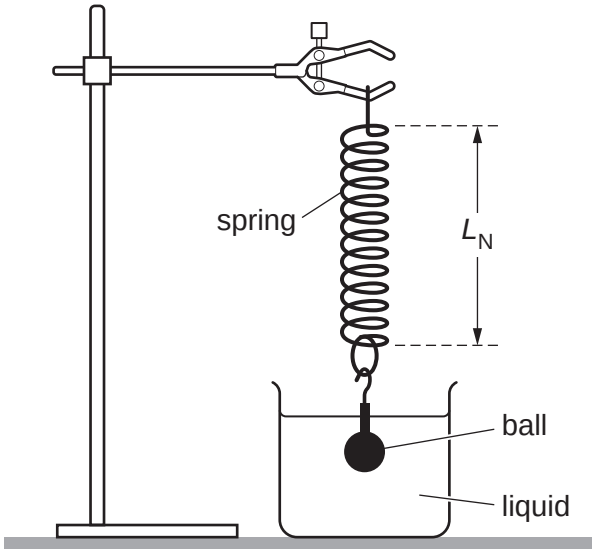

Fig. 3.3

The length L_N of the spring is now 0.088 m.

(i) Calculate the upthrust on the submerged ball.

upthrust = ... N **[2]**

(ii) Calculate the density of the liquid.

density of liquid = ... $kg\,m^{-3}$ **[2]**

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4 **(a)** Fig. 4 shows a circuit with five identical 60 Ω resistors. The battery has electromotive force (e.m.f.) 9.0 V and negligible internal resistance.

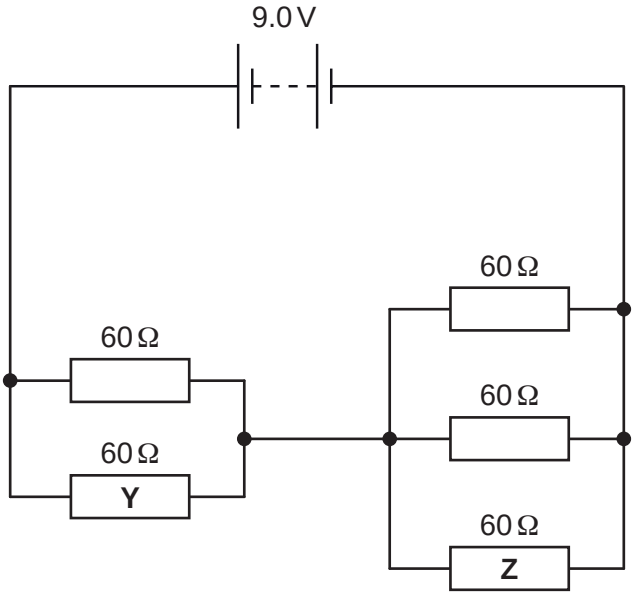

Fig. 4

(i) Show that the total resistance in the circuit is 50 Ω.
Make your reasoning clear.

[2]

(ii) Calculate the potential difference *V* across resistor **Y**.

V = ... V **[2]**

(iii) Calculate the charge *Q* passing through resistor **Y** in two minutes (include an appropriate unit).

Q = ... unit: ..... **[3]**

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(iv) Calculate the energy W dissipated in resistor **Y** in two minutes.

W = ... J **[1]**

(b) Explain how the mean drift velocity of electrons in resistor **Y** compares with the mean drift velocity of electrons in resistor **Z**.

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..... **[3]**

(c) Copper is a metal, carbon is a semiconductor and ceramic is an insulator.

Describe the difference between these three materials in terms of the number density n of free electrons. Include an explanation of the term **number density**.

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..... **[3]**

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5 **(a)** Fig. 5 shows the variation with distance of the displacement for two progressive waves **P** and **Q**.

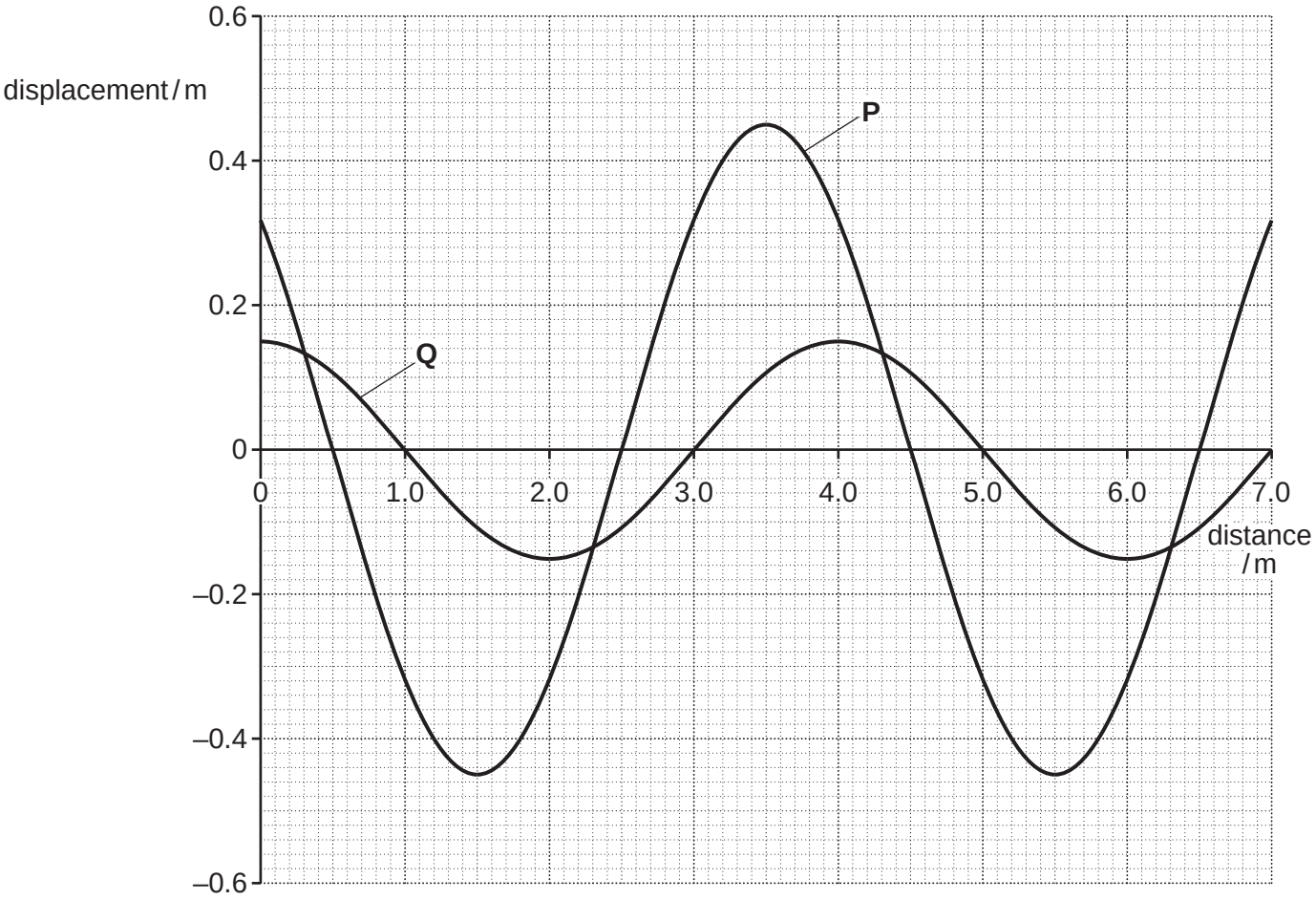

Fig. 5

(i) State the amplitude of wave **P**.

amplitude = ... m **[1]**

(ii) State the wavelength of wave **P**.

wavelength = ... m **[1]**

(iii) Determine the phase difference, in radians, between wave **P** and wave **Q**.

phase difference = ... rad **[2]**

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(iv) Determine the ratio $\frac{\text{intensity of wave } \mathbf{P}}{\text{intensity of wave } \mathbf{Q}}$.

ratio = ... **[2]**

Question 5 continues on page 14

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(b)* A student wishes to investigate how the fringe spacing x of an interference pattern produced by sound waves varies with the frequency f of the sound waves.

It is suggested that $\frac{v}{f} = \frac{ax}{D}$ where

a is the separation of the sources of sound
D is the distance from the sources of sound to the interference maxima and minima
v is the speed of sound in air.

Describe with the aid of a suitable diagram how an experiment can be safely conducted in the laboratory, and how the data can be analysed to determine v. **[6]**

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6 **(a)** In an experiment to demonstrate the photoelectric effect, electromagnetic waves are incident on a silver surface.
Fig. 6 shows the variation with frequency f of the maximum kinetic energy KE_{max} of the photoelectrons.

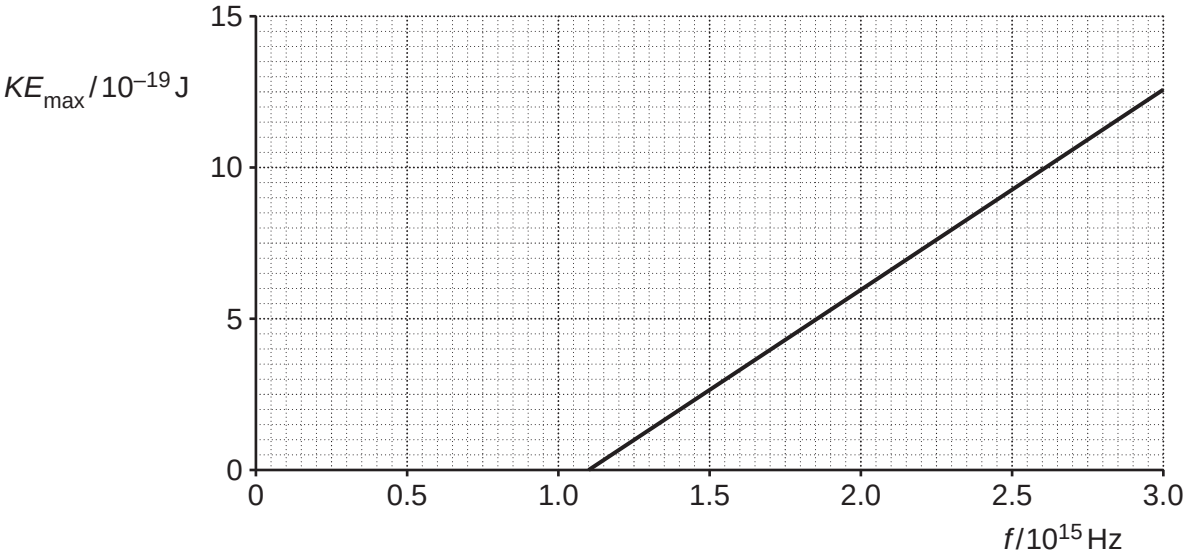

Fig. 6

(i) Define the term **threshold frequency**.

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..... **[1]**

(ii) Use Fig. 6 to state the threshold frequency f_0 for silver.

f_0 ..... Hz **[1]**

(iii) Use your answer in **(ii)** to calculate the work function ϕ of silver.

Give your answer in electron volt (eV).

ϕ = ... eV **[2]**

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(b) Electrons can behave as a wave.

Describe the behaviour of electrons which demonstrates that they have wave properties.

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END OF QUESTION PAPER

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ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

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